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Implementation of renewable energy in Scottish rural area: A social study

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ABSTRACT

Nowadays, renewable energy is considered one of the valuable sources of energy in the energy sector. It is contributing major role in fulfilling the increasing level of global energy crisis. Although most of study of renewable energy is done through its technological development and a few are done in its acceptance level socially. In such consequences, this research considers the social acceptability of renewable energy in terms of economical, environmental and cultural perspectives. As a test bed, Scottish rural areas were considered for this social study, where the areas are regarded as lacking of continuous energy supply due to weak grid and socio-economic growth. This research investigates the intimate and sensitive nature of the social issues in rural Scotland that are important in the communities when decisions are made on renewable energy supply and demand. The social interactions are investigated by means of both interviewing the local residents and distributed questionnaires among them. The responses from the interviews and the questions are analyzed according to the predefined criterion of renewable energy such as willingness to accept, changes of life style, income and pay, and education and employment.

Contents

1. Introduction

Growing concern over environmental issue globally, pushing energy business to move from traditional source of energy from fossil fuel to renewable source of energy [17,20]. The rural areas, where the energy crisis are usually high in terms of demand and supply level need to be figured out for stability. The renewable sources of energy could be better solutions for this comparatively remote and underdeveloped region of any country [10]. The nature of renewable energy matches very closely to that of rural communities. The renewable energy resource is widely distributed such that even the most remote communities have access to some of it and of a relatively low energy density. As a form of energy generation, renewable is essentially very cheap once the initial capital expenditure has been overcome [14]. Its generation is clean in comparison to traditional energy generating methods. For isolated communities, it is a sustainable form of power [27].

Renewable energy generation can be implemented in different formats such as wind farm, hydro scheme, and solar energy. All these sources can easily overcome the ever increasing demands on energy in rural as well as urban areas and ever more pressing difficulties in the supply and generation of traditional centrally generated electricity [21,22]. The investment in renewable energy is being promoted as a new means of diversifying rural development.

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The investment over renewable sources of energy also has limitations in terms of socio-economic impacts over the rural areas such as natural tourism, wildlife, landscape, and air pollution. Therefore, before implementing any formats of renewable energy source in rural area, care should be taken from designing the instrumental features to the operating conditions with the objectives to ensuring the lowest possible adverse socio-economic and environmental impacts.

The very nature of many isolated places makes excellent sites for renewable which makes a large potential energy resource. The Spartan distribution of population in many rural areas makes centralized generation and grid connection costly and problematical and is better suited to the decentralized nature of renewable for energy. In particular, it is the smaller scale systems which have low environmental impacts that are most appropriate to sensitive areas and remote communities. This study as concentrated within the Scotland's rural communities is regarded as lacking adequate development and need to find means to achieve sustainable socio-economic growth. Given that rural Scotland is endowed with a huge natural and sustainable energy source in the form of renewable [1,29–32]. The role of this research project was to develop knowledge about the potential for widespread implementation of renewable energy [36].

This research is particularly focused towards the smaller scale renewable system, where there is particular scope for development. According to Sadler and Spencer [28], five broad areas were identified when considering renewable energy developments namely Environmental, Political, Technical, Geographical and Social Issues. Technical issues have been covered in detail in recent years [25]. Environmental issues have similarly received much attention in recent years too as they have taken their place in the political forum. Through a literary review, a lack of any substantial work on social issues in the renewable energy field was identified which lead to the need for the detailed social study in this research. The economics and performance of renewable systems have also been highlighted.

The remainder of the paper is organized as follows. In Section 2, current literature on renewable energy development is reviewed. The objectives of the research are presented in Section 3, while the research methodology is described in the Section 4. In Section 5, the overall impact of renewable energy development over socio-economic factors is interpreted. The results are analyzed and discussed in Section 6. The implications of the research study are elaborated and concluded in Section 7.

2. Literature review

The development of renewable energy is growing faster due to the era of costly oil and abundant fossil energy. The increasing rate of global energy crisis, ecological responsibility and awareness, political bindings, etc., is forcing energy industries globally to move towards the development of renewable sources of energy [11,15,16,19]. Renewable sources of energy especially suitable for the remote rural areas from where the young and skilled person often leaves due to economical crisis of the region. This is especially true in case of European villages and rural cities that suffer from a continuous decline in population [5,37]. In such areas, the development of renewable energy can be considered as a new economic branch.

The development of renewable energy might contribute to the rural community in three different perspectives such as by creating jobs, by creating local tax income from sold off energy and by reducing the costs of energy after initial set up cost [3,23,38]. The set up of renewable energy is also quite easy as it needs the required space which is mostly available in the rural areas [34]. It is also suggested to emphasize the renewable development in the rural areas due to the regional value creation through the measure for productive economic activity [37]. Other than economical point of views, the renewable development should also be characterized by the generic opinions of rural population about its acceptance. Most market research on public views over the development of renewable energy is descriptive rather than probabilistic statistical analyses to illustrate public beliefs and responses to specific technologies [9].

The social study for the acceptability of renewable energy is considered as an important issue for the widespread implementation in terms of its technologies and the achievement of energy policy targets [2,9]. The social or public acceptance about renewable provides a novel classification of personal, psychological and contextual factors that justify the proper and profitable implementation [6,13]. Conducting the social study needs coherent theoretical frameworks and innovative methodological tools that cover up the prerequisite for more systematic research on affective aspects of public acceptance [39]. The social acceptance also varies from one source of renewable energy to another one. For instance, several studies found that over 70% of respondents widely recognized wind, solar and hydro-power, while in contrast approximately 20% of respondents accept biomass as the source of renewable source of energy [7,8,24].

3. Research objectives

This study starts with an overview of social issues and trends in rural Scotland with the view to establish the need for rural development and the issues it should be addressed. It was decided to investigating the relationship of societal impact with the development of renewable energy and the possible effects with each other. This was done through the social survey that could result particularly in terms of rural development in Scotland. This survey was followed by a discussion of the various issues considered individually; largely identified from interviews, discussions, reading and hypothesizing. The use of questionnaires is explored using Clydesdale, Scotland as a test bed and important inferences and conclusions regarding social factors and renewable drawn in the results and discussion. The social study was conducted to achieving the objectives as identified below:

i. To help in the promotion of renewable energy in Scotland.
ii. To identify the social issues that affect renewable energy developments.
iii. To classify and prioritize the issues and draw some correlations to social indicators such as class and sex.
iv. To identify the issues as aids to or barriers against the development of renewable energies.
v. To demonstrate a simple methodology to asses the interaction between social factors and the renewable energy development at a site.
vi. To investigate the role of renewable energy in rural development.

4. Research methodology

The methodological steps as taken during this study were confined with the pre-defined questionnaires as distributed within the study region and face-to-face interviews with the local inhabitants (Clydesdale, Scotland). The questionnaires and the interviews were related to the social interaction with renewable energy and the essential information was collected and assessed critically. Due to the inadequacies of available resources, at all stages an intrinsic analysis had been made to determine the strengths, weaknesses

and values of the methodology. The questionnaires were used as the means of assessing the social factors at the studied site. In helping to achieve the overall aims of this social study, the questionnaires had the detailed aims that can be presented as follows:

i. Public opinion on renewable energy acceptance.
ii. Public depth of knowledge on renewable energy.
iii. The extent of public concern over potential renewable energy developments.
iv. Relative weighting of the most important issues (employment, pay, education, health, etc.).
v. Public willingness to accept renewable energy developments locally.
vi. Degree of lifestyle change that is acceptable in moving to renewable energies.

4.1. Questionnaires: problems identified prior to use

The interests of the study were inevitably being reflected in the distributed questionnaires. In realizing this fact, it was hoped that the degree of biasing can be minimized by careful consideration of the questions, structure, wording and format. Research interests lied in the propagation of renewable energies and the danger exists that the respondents will be influenced in this direction. The constraints of enough time, money and manpower did not allow a representative sample to be taken. In assessing the methodology and results this was taken in mind. The questionnaire sample was distributed among the respondents at the time of survey.

During the day time, this leads to a sample lacking from the main wage earners and containing those who are most likely to be at home such as the unemployed persons, mothers of young children, and the retired or elderly residents. For this reason, the survey was conducted considering the 'drop and collect' questionnaire method that enabled to try and catch the respondents in the evening those who may be absent during the day. It was also decided that the questionnaires be circulated during the holiday periods such as weekends for the same reasons. Every attempt was made to minimize the questionnaire length while optimizing the amount of useful data that could be gathered.

In keeping the time span shorter, the attention and interest of respondents was maximized. The questionnaires were initially designed to be completed within 15 min but it was found to be insufficient in order to allow the collection of all the data required and hence it was lengthened. For personal safety reasons, the surveys were conducted in pairs. Each pair consisted of a male and a female who shared the questioning and answering equally. A mixed sex pair was also used so as to minimize intimidation of the interviewee, especially important in the case of women. The person not interviewing was also assessed by the surveyors with the objective to reduce biasing and assessed the authenticity of the respondent's answers.

4.2. Interviews: restriction to wind-power

In this research study, the face-to-face interviews were concentrated with the development of possible wind-firm locally. It makes the questionnaires simple and understandable to the respondents and easy to analyze the outputs. The development of wind-firm in UK is considering as the highest profile in energy sector, receiving growing media attention from all traditional sources such as television, radio and newspapers, as well as other sources such as specialist publications.

The controversy and interest have already been generated by the development of wind-power and it is believed this will be the renewable energy which contains the most knowledge and opinion within the general public and that which is easier to consider in hypothesis. By narrowing down the scope, the questionnaires can be more specific. It is easier to consider a specific idea than a general context. This restriction should give a lead to respondents, avoiding inability to grasp abstract concepts, but without significant biasing. It was also the case that the wind resource is the most important source of renewable energy in Scotland, estimated at a theoretical potential of 100,000 MW by the Scottish Renewable Energy Study.

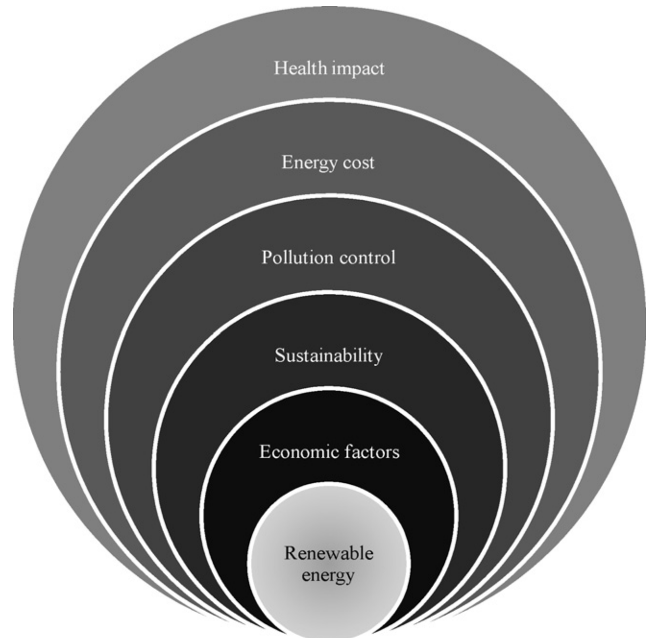


Fig. 1. Major factors affecting the development of renewable energy.

5. Impact of renewable energy development over socio-economic factors

This study included the assessment of socio-economic factors that would be affected by the development of renewable energy in the test region. The development of renewable energy can affect over socio-economic factors both in positive and negative ways to the local community. For isolated or off-grid places socio-economic development can be hindered by a poor energy supply and high fuel costs [33]. A conversion to an autonomous or sustainable supply such as renewable can make the energy sector a catalyst for socio-economic development. Better or increased energy supply can aid local business in becoming established or in expansion. The power from a renewable scheme would be extremely beneficial if supplied cheaply. Jobs could be created, better incomes attained and an all round increase in the quality of life achieved. Specifically, the study addressed the spins off benefits and possible limitations that directly affect the local community. The major factors affecting the development of renewable energy can be presented in Fig. 1 and discussed briefly in the following paragraphs:

(i) Economic context

As well as the above mentioned effects, a renewable scheme can input into the local economy during all the construction phase via the purchase of materials and equipment and the payment of wages to those involved with the development. In addition, there may be input from land rental money and rates if the scheme is not communally owned. Negative economic effects may arise from the displacement of trade based on the former energy supply and the loss of trade profits and wages therein.

(ii) Sustainability issue

It is an accepted view that world supplies of fossil fuel reserves are going to run out and it is sensible to attempt to conserve them. In accordance with this the price of the traditional fossil fuels is expected to increase to reflect this. Renewable energy provide a sustainable alternative for those concerned and are likely to decrease in cost as technology improves [14].

(iii) Pollution control

Many people are well aware that fossil fuels are a major contributor to environmental damage such as acid rain and global warming. In addition, nuclear power is not seen as an acceptable alternative by many. Sources of renewable energy are generally accepted as clean or environmentally friendly and this is a very strong motivating factor for some.

(iv) Energy costs

At present grid electricity is not considered expensive and there is little motivation or obvious benefit to be gained in switching to renewable [12]. Non-grid connected properties often rely on imported fuels such as diesel which is accordingly expensive. In such cases renewable energy can be highly competitive or even cheaper and hence more desirable. It is high energy prices that can result in social derivational effects due to the inability to afford adequate energy for basic needs.

(v) Security of supply problems

Both the renewable sources of energy and imported fuels can suffer with this common problem although renewable can be improved by using storage. Grid connections in rural and particularly in the more remote areas have been identified by many as susceptible to breaks in supply, particularly in the winter, some of which can last for several weeks. If the current supply cannot adequately meet the expected demand level or is restricted as is often the case for non-grid properties or imported fuels, then it may be possible to meet demand by addition of, or complete change to a renewable energy.

(vi) Education

The education of the population to the benefits of renewable energy as well as its problems would probably be the single greatest aid to future renewable development. It is generally accepted that changing population consensus views should start from an early age i.e. in school. This is of course a long term effect but as valid and complementary to environmental education and energy efficiency education.

(vii) Health impact

The health implications of renewable energies are small and generally indirect on a local scale. On the global scene issues such as global warming, acid rain and other pollution effects make the health implications of renewable much clearer in terms of benefit. Changes in the local environment are most likely to have an indirect effect on health. For examples, in case of wind-power the hazards are electro-magnetic radiation and noise; for hydro-power the effects on the local water supplies such as river flows, water tables and quality and for bio-mass, the substitution of food crops, contaminations from leakages and air pollution. All of these could show up as ill-health in their effects on people.

(viii) Lifestyle changes

There are three trade-offs to be made for the inception of a renewable energy scheme; cost, available resource and ability to meet and match demand. The chosen compromise will likely involve some lifestyle changes. Clearly, in accepting a renewable energy scheme certain lifestyle changes will be inherent. There may be need to forego some of the luxury that modern electrical appliances can afford. There may be a need to accept that certain important chores which depend on electricity may have to wait until power is available.

The acceptance of renewable energy is more likely if the community feels that its current supply is problematical. It may be that the lifestyle changes mentioned above are wholly acceptable as they are already equivalent to or an improvement on the current situation. Many rural dwellers already endure hardships of lifestyle and perceived alterations due to a change to renewable energy may not be considered as hardships at all but rather as a normal part of everyday life. In this case, the willingness to accept renewable sources of energy is likely to rest more on economic and other considerations.

(ix) Tourism

In any renewable energy project there will exist a potential for visitors to come and see the system. Visitors to the development of renewable energy may be perceived as a positive or negative factor by local communities. In the first case, the people are seen as making a positive economic input to the community by spending time and money there. In the second, the visitors are seen as intrusive and likely spoiling a quiet, peaceful and desirable area to live. In deciding which is the case the site needs to be assessed in terms of proximity to local residents and how access relates to local residents.

By survey or interviews local opinion can be tested. It is then relevant to ask whether the visitors need to pass trough the community access the site. If the answer to this question is no then both the positive and negative impacts are reduced. If they pass through the community then a nuclear settlement is best placed to concentrate visitors by acting as a firmer focus for services such as cafes, and restaurants. A widely spread community will be less able to draw the tourists. An established tourist trade may well be better placed to realize and capitalize on any increased potential if the two are complementary. In developing renewable energy sites as tourist attractions positive advertising and information is crucial. Boosts in tourism could boost the local economy, creating jobs and increasing living standards or conditions, also giving an increased incentive to stay in or move to the area. In this case, communal spirit and pride in the area could also increase.

6. Result analysis and discussion

The results after analyzing the questionnaires and face-to-face interviews from this research study were found very interesting in terms of specific issues and peoples concerns on the implementation of the renewable energy technologies in the rural areas. Different figures as displayed below illustrate these analysis and potential outcomes. Brief descriptions concerning each of the figures are also stated accordingly.

Fig. 2 displays the people's awareness on environmental issues. From Fig. 2, it is seen that 41 of local respondents aware of pollution, 20 aware of green house effect and 15 aware of ozone layer depletion. Other environmental issues such as acid rain, global warming, deforestation and biodiversity are concern for 12, 5, 4 and 3 of the respondents respectively.

The people's concern about solving the environmental pollution related with the development of renewable energy is presented in Fig. 3. It is seen from Fig. 3 that 44% of rural people believe that the above mentioned environmental problems can be solved by using renewable energies such as solar, wind-power, and hydro-power, whereas 28% believe that a little can do by the renewable development and 24% do not know about it. 4% respondents believe that renewable energy does not solve the problems related with the environmental pollutions.

The acceptability of a single wind turbine or a wind farm locally by the residents is measured in terms of both questionnaires and interviews and the results are displayed in Figs. 4 and 5 respectively. From Fig. 4, it is seen that people are fairly open to suggest the wind-power developments and the promise of some incentive

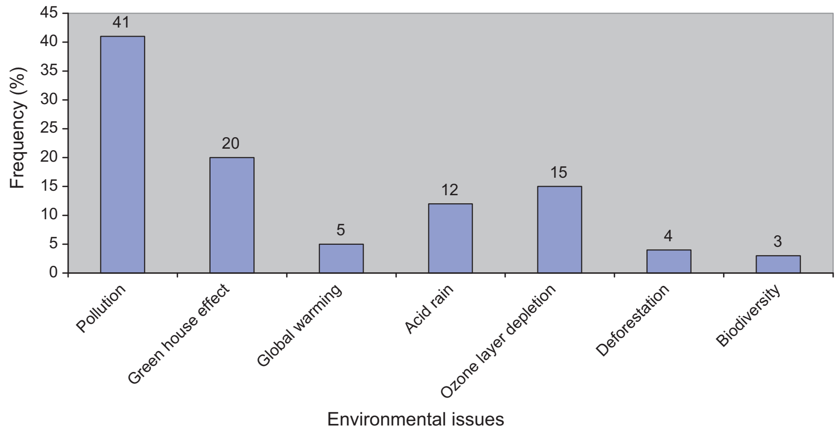


Fig. 2. People's awareness on environmental issues.

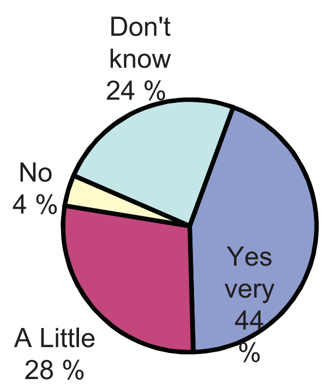


Fig. 3. Peoples belief to solve environmental pollution by renewable energy.

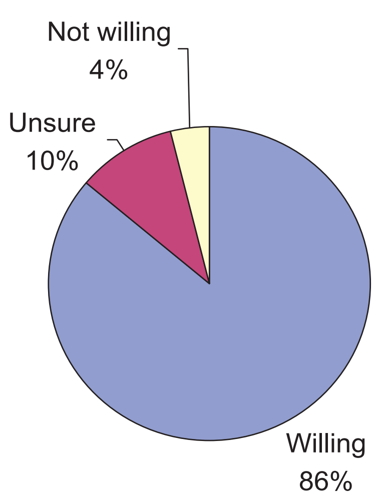


Fig. 4. Willingness to accept a single wind-turbine locally.

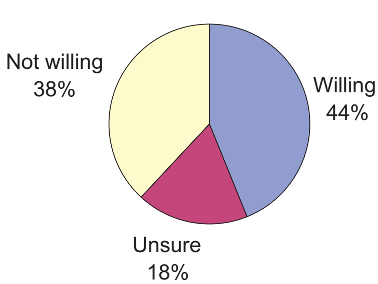


Fig. 5. Willingness to accept wind-farm locally.

would easily make local wind turbine developments acceptable. It is the 86% of people willing to accept a single wind turbine, 10% of people are unsure and only 4% against it. Whereas, from Fig. 5, it is observed that change to a large wind-farm locally drew much more negative responses than to develop a single wind-turbine only. Only 44% people are willing to accept, 38% are not willing to accept and 18% are not sure about accepting a wind farm locally. This is because the wind-farm creates more noise that disturbing the quiet environment of the rural community.

As stated early, the development of wind farm is not acceptable by most of the residents rather than accepting a single wind turbine due to several issues such as noise pollution, visual intrusion, TV interference, and effect on wildlife, as presented in Fig. 6. From Fig. 6, it is observed that 38 of local residents are concern about noise pollution, 22 are on visual intrusion, 18 on TV interference, 14 are on safety, 8 on farming/land usage and 28 are no more concerned about it.

In this survey, the knowledge of local residents about the cost of renewable energy in compare to the cost of energy from the national grid was assessed and the outcomes are presented in Fig. 7. From Fig. 7, it is seen that 54% of the local residents think the cost of renewable energy is less than the cost of energy from the national grid, while 32% do not know about the differences, 10% think it is more costly and 4% think it is same as of the cost of national grid.

In this survey, the questionnaires and interviews were also related with respect to the concern of environmental measures as people took in their daily livelihood. Fig. 8 displays the different environmental measures as taken by the local residents at Clydesdale, Scotland. From Fig. 8, it is noticed that the highest 82 rural people took energy conservation measures, while 60 people took waste recycling, both litter/clean up and benign practice are adopted by 58 residents each and 10 and 3 residents were the member of green organization and protest/demonstrated for environmental measures respectively.

All the figures stated above have given an overall scenario of peoples concern and knowledge of renewable sources of energy. This information will be very much helpful to establish any sources of renewable energy in an area of concern. This social study may be varied from region to region or country to country but it helps to acquire an initial idea of any renewable energy development or study.

7. Research implications and conclusions

The prospect of developing renewable energy in the rural community or countryside is quite high in present days and in future too. It is nowadays a concern of how much rural population can

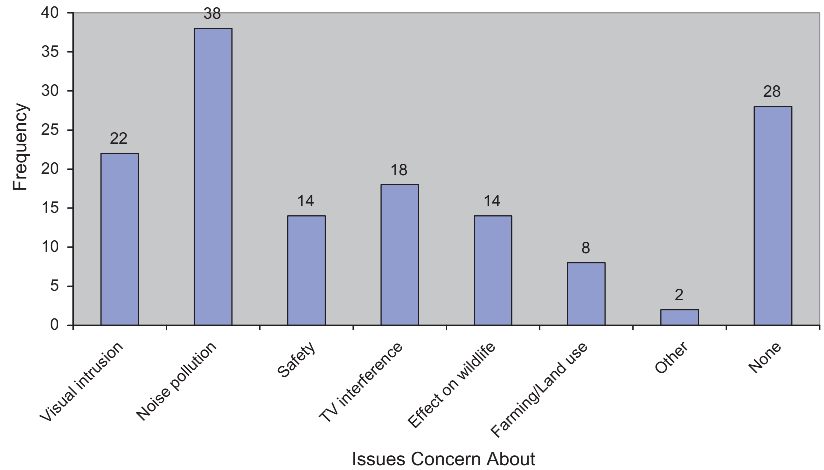


Fig. 6. Various issues concern for wind-farm development locally.

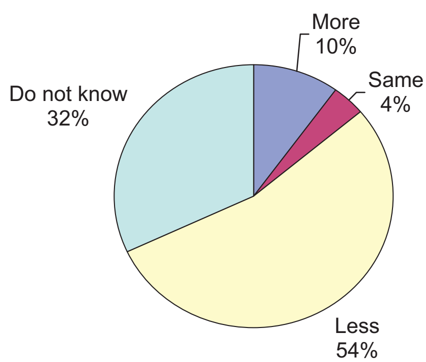


Fig. 7. Peoples knowledge of electricity bills for renewable energy in compare to national grid.

be benefited financially, environmentally and socially from the development of renewable energy. Most of the research studies on renewable energy are focused on technical and economical point of view but few concerns with social study [5]. It is therefore, a prime research scope that the development of renewable is not only related with the technical details but also need to consider its acceptability socially and/or culturally. The aim of this research study was to critically analyze the attitude and acceptability of renewable energy development in the rural area. The test bed for this social study was concentrated within the rural areas in Clydesdale district in Scotland.

This study was conducted in qualitative manner that focused mainly on face-to-face interviews and distributed questionnaires within the local inhabitants. The outcomes from this study were categorized from various corners of social impacts over the renewable energy development, especially development of a single wind turbine or small scale wind-farm locally. The aims as defined from the social study and the questionnaires as a whole have been achieved. The discussion of the questionnaire results contains important conclusions which impact on government policy, education, business and society and together with the main body demonstrates the relevance and importance of social issues in renewable energy, particularly to rural development. Three fundamental conclusions that are identified from the study can be given as:

- Many people could be motivated to use renewable in rural Scotland due to inadequacies of week-grid and also by the environmental implications.
- Involvement of the local community plays a crucial role in determining the acceptability of a renewable energy development.
- A small scale, decentralized approach to renewable energy use is probably the best way to aid its uptake while developing rural areas at the same time.

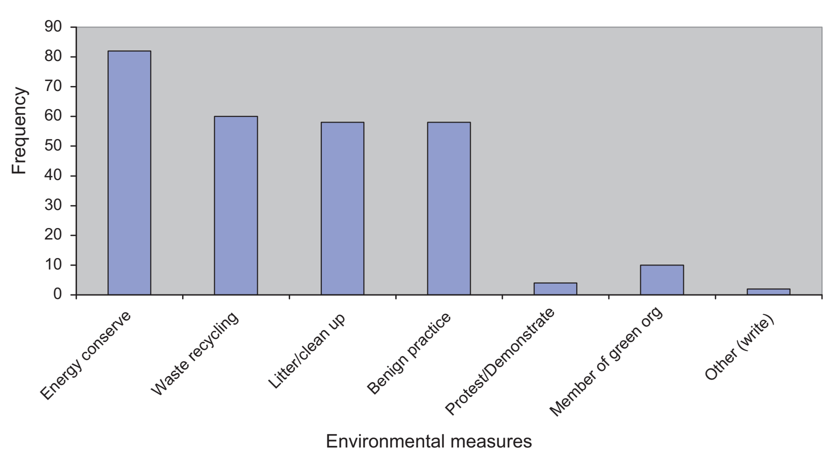


Fig. 8. Environmental measures taken by the people.

The methodology of questionnaires and interviews that is demonstrated here does have potential sources of error which must be recognized and minimized, but can be used as an effective means of eliciting information and assessing social factors in the consideration of renewable energy developments. This study could have several limitations such as personal biasing of opinion from one people to another, level of maturity and knowledge about renewable energy of the local inhabitants, duration and place of interviews. From this study, the generic concerns of rural population about the development of renewable energy project was achieved which might be helpful guidelines for decision making process for future development of renewable energy in remote and decentralized places globally. It fosters the decision making process in terms of technical, financial, environmental, and social aspects of the development of renewable energy.

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Further reading

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